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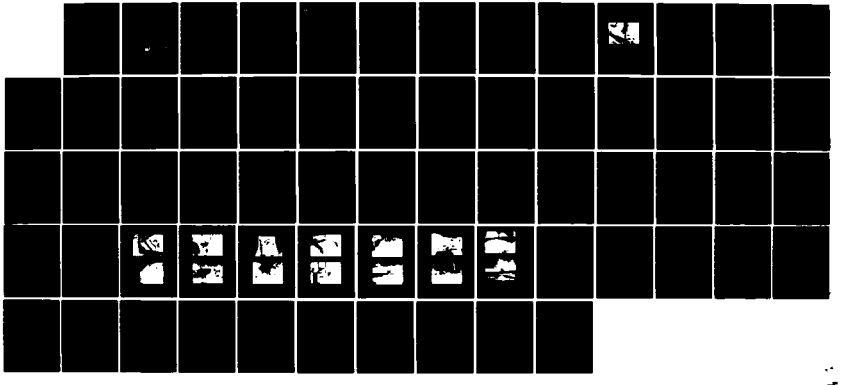

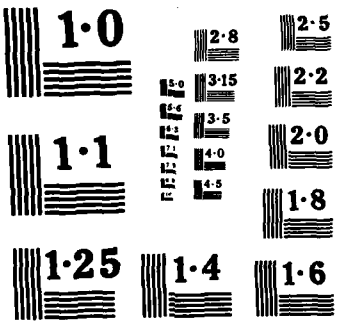

MERRIMACK RIVER BASIN

BENNINGTON, NEW HAMPSHIRE

PAPER MILL DAM

NH 00251

STATE NO 22.06

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

FEBRUARY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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4. TITLE (and Subtitle) Paper Mill Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Bennington, New Hampshire
Contoocook River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam has a hydraulic height of 13 ft. and is 280 ft. long. It is a run of the river concrete gravity dam with a spillway length of 142 ft. The dam is in fair condition with a few major concerns. It is small in size with a significant hazard classification. A major breach at top of dam would result in the loss of few, if any lives and appreciable property damage.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

FEB 14 1980

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

Inclosed is a copy of the Paper Mill Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Monadnock Paper Mills, Bennington, New Hampshire.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00251
Name of Dam:	Paper Mill Dam
Town:	Bennington
County and State:	Hillsborough County, New Hampshire
River:	Contoocook River
Date of Inspection:	November 20, 1978

BRIEF ASSESSMENT

Paper Mill Dam has a hydraulic height of 13 feet, is of varied topwidth, and totals 280 feet long. It is a run-of-the-river concrete gravity dam with a spillway length of 142 feet. The spillway has a 45° inclined downstream face. The head and waste gates are located in the north abutment. The dam spans a reach of the Contoocook River, and is located in south-central New Hampshire. Maximum storage capacity is about 50 acre-feet. Paper Mill Dam is used for industrial process water as well as for hydropower purposes. The pond is about 1140 feet in length with a surface area of about 5 acres.

The dam is in fair condition. Major concerns are: structural stability of the spillway under conditions of the test flood and the deteriorated concrete in the dam and gate structures.

Based on small size and significant hazard classifications in accordance with Corps guidelines, the test flood is 1/4 Probable Maximum Flood (PMF). A test flood outflow of 15,760 cfs (83 csm) would overtop the dam by about 5.2 feet (9.1 feet over spillway crest). The spillway will pass 3,830 cfs or about 24 percent of the test flood. A major breach at top of dam would result in the loss of few, if any lives and appreciable property damage.

The owner, Monadnock Paper Mills, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 within one year after receipt of this Phase I inspection report.

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Paper Mill Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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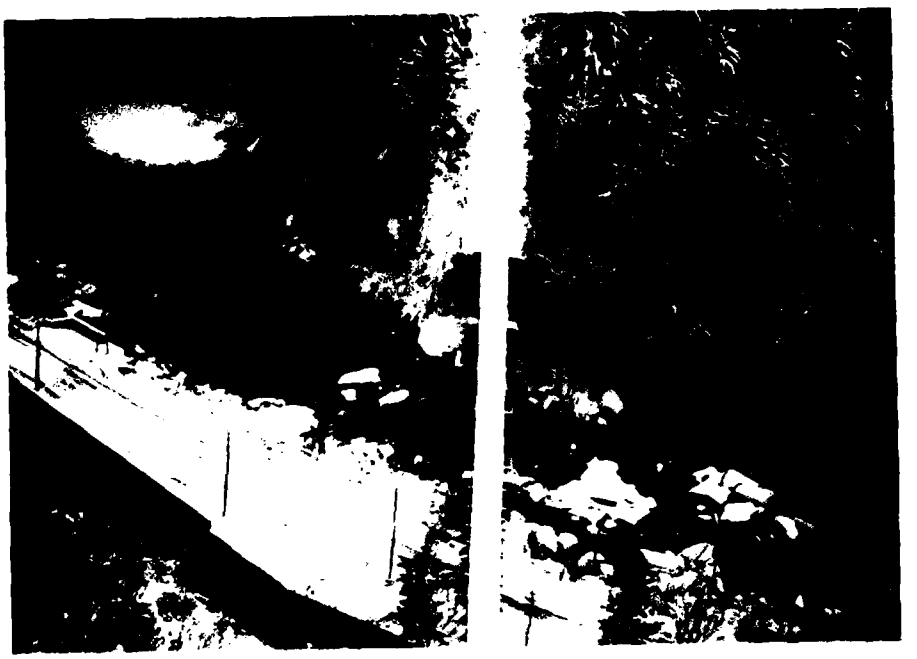

Figure 1 - Overview of Paper Mill Dam.

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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

Anderson-Nichols & Co., Inc.
CONCORD NEW HAMPSHIRE

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PAPER MILL DAM
LOCATION MAP

CONTOOCOOK RIVER NEW HAMPSHIRE

SCALE: SEE BAR SCALE
DATE: FEBRUARY 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
PAPER MILL DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Paper Mill Dam is located in Bennington, New Hampshire. The dam is a run-of-the-river dam spanning the Contoocook River approximately 43 miles above its confluence with the Merrimack River in Concord, New Hampshire. The Contoocook River is a major tributary in the Merrimack River Basin. Paper Mill Dam is shown on U.S.G.S. Quadrangle, Hillsboro, New Hampshire with coordinates approximately at N43°00'24", W71°55'36", Hillsborough County, New Hampshire. (See Location Map page vii.)

h. Design and Construction History. One drawing was disclosed of the Paper Mill Dam and Head Gates. This drawing was done by Aberthaw Construction Company in Boston, Massachusetts and dated August 14, 1922. It shows the existence of a previous dam. The drawing indicates that the existing dam was constructed approximately 5.5 feet downstream of the old dam with its crest at the same elevation as the old dam. No details of the previously existing dam were disclosed. This drawing also shows an ogee spillway. Apparently this downstream face was repaired in 1939 and changed to the present straight face inclined at 45°.

i. Normal Operating Procedures. No written operating procedures were disclosed for Paper Mill Dam. The Contoocook River discharge to the damsite is primarily controlled by the Powder Mill Pond Dam, located approximately 5,600 feet upstream. Before reaching the Paper Mill Dam, the discharge from the Powder Mill Pond also flows over the Monadnock Power Station Dam and the Pierce Power Dam located about 2,100 feet and 1,200 feet upstream, respectively. Monadnock Paper Mills own and control each of these dams. Generally, they operate the Powder Mill Pond Dam to provide sufficient discharge at the Paper Mill Dam for use in power generation and industrial water supply in their paper processing plant.

It is reported that every July the waste gate is opened to release accumulated sediment which has built up behind the dam. This annual opening also permits inspection of the gate and the gate operating facilities.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 191 square miles (122,240 acres) of gently rolling terrain.

b. Discharge at Damsite.

(1) Outlet works - waste gate 8'H x 6'W @ invert elevation 620.6' MSL. Gate capacity at top of dam - 710 cfs @ 631.5' MSL. Three head gates 8'H x 6'W @ invert elevation 620.3' MSL. Capacity is controlled by the turbine capacity which is unknown.

(2) The maximum discharge at damsite - a U.S.G.S. gaging station with a drainage area of 368 square miles is located on the Contoocook River near Henniker, New Hampshire. A maximum discharge of 22,200 cfs was reported at this gaging station during the September 1938 flood. Using this figure, the maximum discharge at damsite can be interpolated to be approximately 12,500 cfs.

(2) Length of spillway crest pool - 1,140

(3) Length of flood control pool - not applicable

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 25 (approximate)

(4) Top of dam - 50 (approximate)

(5) Test flood pool - 85 (approximate)

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 5 (approximate)

(4) Test flood pool - 7 (approximate)

(5) Top of dam - 6 (approximate)

g. Dam

(1) Type - concrete gravity dam

(2) Length - 280'

(3) Height - 19' (structural height)

(4) Top width - varied

(5) Side slopes - upstream face is vertical; downstream face of spillway is straight but inclined at 45°.

(6) Zoning - not applicable

(7) Impervious core - not applicable

(8) Cutoff - unknown

(9) Grout curtain - unknown

SECTION 2
ENGINEERING DATA

2.1 Design

No original design data were disclosed for Paper Mill Dam.

2.2 Construction

One drawing prepared by Aberthaw Construction Company, Boston, Massachusetts, was found in the files of the New Hampshire Water Resources Board (NHWRB). This was a drawing of the Paper Mill Dam and Head Gates and was dated August 14, 1922. A copy of this drawing can be seen in Appendix B.

2.3 Operation

No written engineering operational data for power and process water operations have been prepared. Oral instructions have been in effect during the history of the operations. These instructions are transmitted from supervisors to subordinates.

2.4 Evaluation

a. Availability. Limited engineering data were available for Paper Mill Dam. A search of the files of the NHWRB and direct contact with the owner revealed only a limited amount of recorded information.

b. Adequacy. Because of the limited amount of detailed data available, the final assessments and recommendations of this investigation are based on the visual inspection and hydrologic and hydraulic calculations.

c. Validity. The visual inspection is generally consistent with the 1922 drawing by the Aberthaw Construction Company. An ogee spillway crest is shown on this plan; the visual inspection of this dam shows a straight downstream face angled 45°. This change apparently occurred during repairs in 1939.

An earth dike has been constructed north of the roadway to effectively cut off high water from flowing directly into the canal. The dike is approximately 1.7 feet above the roadway and 9.3 feet above the spillway crest. The dike is approximately 190 feet long and 6 feet high. The top of the dike is 9 to 10 feet wide with side slopes of about 3H:1V. The side slopes are wooded and the exposed portion of the dike near the roadway shows a gravel surface which would be susceptible to erosion during high water conditions. (See Appendix C - Figure 4.)

A 12-inch concrete pipe about 20 feet in length extends through this dike. If water should ever pond behind the dike, some discharge could be passed through the pipe into the canal. The inlet to this pipe contains stoplog slots which would provide a means of controlling flow.

On a return visit to the dam on April 19, 1979 it was observed that a piece of the dam crest (approximately 2 cubic feet) had apparently spalled away near the center of the dam. The depression caused by the spalling is reflected in the water surface passing over the crest. (See Appendix C - Figure 15.)

c. Appurtenant Structures. The outlet works and gate-control structures are located at the north abutment. (See Appendix C - Figure 5.) Significant spalling and erosion of the concrete on the downstream side of the gate structure was noted. The presence of bedrock in the discharge channel immediately downstream of the gate structure would indicate that the abutment is on bedrock, which is consistent with design drawings dated 1922 which show the gate structure to be founded on "ledge."

The waste gate is located adjacent to the north abutment of the spillway. The timber gate is manually operated by a mechanism located directly above the opening. At the time of inspection leakage was noted through the timber gate. (See Appendix C - Figure 6.) The downstream concrete wall to the right of the low-level outlet was noted to have deteriorated and spalled from the base to approximately 2 feet up the wall. (See Appendix C - Figure 7.)

The head gates are located adjacent but perpendicular to the waste gate. The leading edges of the head gate inlet structures have also deteriorated and spalled to a depth of approximately 1 - 3 inches. (See Appendix C - Figure 8.) It appeared that some portion of the gate support structures had been recently repaired. The timber gates were inspected in the raised position and found to be in good

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

Although no written operational procedures have been developed for Paper Mill Dam, Messrs. Gordon Bishop, Chief Engineer and George Edwards, Maintenance Superintendent, are fully familiar with the operational procedures of their four dams, Powder Mill, Monadnock Power, Pierce Power, and Paper Mill, and the appurtenant facilities including the operations for hydropower generation. Mr. Bishop maintains complete records of all maintenance performed including cost records and operates on an annual budget. Each summer maximum releases of water from Powder Mill Dam are made and power is generated for a period such that the Powder Mill Reservoir is drawn down to about two feet below the concrete crest. This procedure provides additional storage enabling the lower three ponds to be drawn down for visual inspection and maintenance, if required. The gates at Powder Mill are then closed and the lower three dams are dry for a week to 10 days. This procedure is usually accomplished in July. Accumulated sediment which has built up behind the dam passes downstream through the waste or power gates (waste gate at Paper Mill). The head gates are operated to provide sufficient discharge into the mill building for use in power generation and industrial process water.

4.2 Maintenance of Dam

Monadnock Paper Mills is responsible for the maintenance of Paper Mill Dam. No written maintenance program has been prepared. Maintenance is performed as required; larger items are budgeted and scheduled for completion annually. Inspection of the upstream face of the dam is accomplished during the drawdown period. Mill maintenance personnel are aware of spalling and loose concrete in the dam face and funds are approved for repairs to be done in September and October 1979.

4.3 Maintenance of Operating Facilities

The annual releasing of sediment through the waste gate enables the testing of the operating facilities to ensure that they are functional.

4.4 Description of Any Warning System in Effect

A gage is located on the downstream face of the road crossing located approximately 2,200 feet downstream of Paper Mill Dam. During floodflow periods (usually occurring each spring) when the water reaches 3 feet on this downstream tailwater gage (0' at gage-598' MSL) a flood watch around the clock is initiated by maintenance personnel. Two men ride up and down the road along the stream to observe conditions. Evacuation of the

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Paper Mill Dam is a low, run-of-the-river concrete gravity dam which impounds a reservoir of small size. The abutments are concrete and would probably withstand considerable overtopping before serious damage would result. The dam has 3.9 feet of freeboard available before overtopping would occur on the north abutment. The south abutment is 4.1 feet above spillway crest. The northerly dike has a crest elevation averaging 9.3 feet above spillway crest.

b. Design Data. No hydrologic or hydraulic design data were disclosed for Paper Mill Dam.

c. Experience Data. Low flow and flood profiles for the March 1936 and September 1938 floods are shown on the Contoocook River, New Hampshire Plan and Profile, Sheet 5 of 7, February 1939, Revised February 1951, U.S. Engineer Office, Boston, Massachusetts. (See Appendix B.)

d. Visual Observations. At the time of inspection, no visual evidence was noted of damage to any portions of the concrete structure caused by excessive discharges.

e. Test Flood Analysis. Paper Mill Dam is classified as being small in size having a hydraulic height of 19 feet and a maximum storage capacity of 50 acre-feet. The dam was determined to have a Significant Hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was determined to be 1/4 Probable Maximum Flood (PMF).

Using the 1/4 PMF, the test flood discharge was determined to be 15,760 cfs. The overtopping analysis indicates that the dam would be overtopped by 5.2 feet during the test flood. The maximum spillway capacity at top of dam is 3,830 cfs which is 24 percent of the test flood discharge. However, because both abutments are concrete, they would probably withstand considerable overtopping before damage. The northerly dike has a crest averaging 9.3 feet above spillway crest and would therefore be on the verge of overtopping during the test flood.

f. Dam Failure Analysis. The impact of failure of Paper Mill Dam at normal flow conditions and at top of dam were assessed using the Guidance of Estimating Downstream

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination indicated the following evidence of potential long-term stability problems:

(1) Deterioration and erosion of the concrete in the main dam, particularly along the cold joints and at the non-overflow portion at the south abutment of the dam.

(2) Spalling and erosion of the concrete on the downstream side of the waste gate structure.

b. Design and Construction Data. A drawing dated 1922 shows the plan of the dam and a typical cross section. The cross section shown on this drawing has an ogee downstream face. No construction data were available.

c. Operating Records. No operating records pertinent to the structural stability of the dam were available.

d. Post-Construction Changes. The dam was apparently repaired in 1939, which is apparently the time when the original ogee downstream face was changed to the present straight face inclined at 45°.

e. Seismic Stability. This dam is located in Seismic Zone No. 2 in accordance with recommended Phase I guidelines does not warrant seismic analysis.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Remove trees and brush for a distance of 25 feet upstream and downstream of the south abutment.

(2) Visually inspect the dam once a month.

(3) Establish a written surveillance and warning program to follow in the event of emergency conditions.

(4) Engage a Registered Professional Engineer to make a complete technical inspection once every two years.

7.4 Alternatives

None.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

TIME 8:30 AM

WEATHER Clear, cold (40°F)

W.S. ELEV. U.S. 627.8 DN.S. 618.5

PARTY:

1. Warren Guinan
2. Robert Langen
3. Stephen Gilman
4. Ronald Hirschfeld
5. Robert Ojendyk
6. Leslie Williams
7. Harold Wilcox (1/3/79)
8. John Falcione (1/3/79)
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	R. Langen	
2.	Structural	S. Gilman	
3.	Soils & Geology	R. Hirschfeld	
4.	Mechanical	H. Wilcox	
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Northern Dike NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	Ranges from 636.6 - 637.7
Current Pool Elevation	Not applicable
Maximum Impoundment to Date	Not applicable
Surface Cracks	None noted
Pavement Condition	Not applicable
Movement or Settlement of Crest	None noted
Lateral Movement	None apparent
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good at tiein with road abutment on south end
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes	Foot path visible on dike crest
Sloughing or Erosion of Slopes or Abutments	Slight erosion at south end exposed gravel surface. Slopes wooded.
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or Near Toes	None apparent
Unusual Embankment or Downstream Seepage	None apparent
Piping or Boils	None visible
Foundation Drainage Features	None apparent
Toe Drains	None visible
Instrumentation System	None visible
Vegetation	Grassed crest

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Intake Channel & Structure NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Contoocook River
Slope Conditions	Good, vertical concrete sidewalls
Bottom Conditions	Not visible beneath pond level
Rock Slides or Falls	None
Log Boom	See below
Debris	Little
Condition of Concrete Lining	Not visible beneath pond level
Drains or Weep Holes	None apparent
b. Intake Structure	
Condition of Concrete	Concrete in good condition; piers have deteriorated and spalled
Stop Logs and Slots	Good

Logboom - at upstream of intake consists of a wood log with vertical boards. This stops floating trash from reaching the intakes. The top log was weathered and in poor condition.

Steel trash racks were rusted but in good condition.

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Control Tower NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good. No evidence of movement
Spalling	1" - 3" on leading edges of gate piers
Visible Reinforcing	None
Rusting or Staining of Concrete	None visible
Any Seepage or Efflorescence	Little on faces of abutments and piers
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None
Cracks	Limited to hair line cracks
Rusting or Corrosion of Steel	Only at embedded elements of steel
b. Mechanical and Electrical	
Air Vents	4 wooden sluice gates. Hand operated wheels. Gates are in good condition
Float Wells	Not applicable
Crane Hoist	Not applicable
Elevator	Not applicable
Hydraulic System	Not applicable
Service Gates	Good condition - operating mechanism - good condition
Emergency Gates	Not applicable
Lightning Protection System	Not applicable
Emergency Power System	Not applicable
Wiring and Lighting System	Not applicable

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Outlet Structure & Channel NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good
Rust or Staining	None visible
Spalling	Significant deterioration of north wall d/s of low-level outlet at base
Erosion or Cavitation	
Visible Reinforcing	None visible
Any Seepage or Efflorescence	None visible
Condition at Joints	No apparent movement
Drain holes	None apparent
Channel	
Loose Rock or Trees Overhanging Channel	Some trees and brush adjacent to channel, which is wide.
Condition of Discharge Channel	Good. One log across channel immediately downstream of low-level outlet.

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Spillway Weir NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Contoocook River
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees and brush adjacent to channel which is wide - not visible beneath pond surface
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	Fair. Weir has surface erosion ½" deep and 2" deep at concrete pour joints.
Rust or Staining	None visible
Spalling	Some spalling on training walls. See note below.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Some on training walls at hairline cracks
Drain Holes	None apparent
c. Discharge Channel	
General Condition	Good - very rocky
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Some trees and brush adjacent to channel which is wide.
Floor of Channel	Bedrock, with some large boulders
Other Obstructions	Four railroad - bridge piers
	Note: Left abutment and training wall has spalled 4" deep. One area on d/s face about 4' below u/s water line has seepage through concrete. D/s face spalled from frost action.

PERIODIC INSPECTION CHECKLIST

PROJECT Paper Mill Dam, N.H. DATE November 20, 1978

PROJECT FEATURE Service Bridge NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION	
OUTLET WORKS - SERVICE BRIDGE	Over low-level outlet	Over Intake & Bar Rack
a. Super Structure		
Bearings	None	None
Anchor Bolts	None	None
Bridge Seat	None	None
Longitudinal Members	None	None
Underside of Deck	Good	Fair
Secondary Bracing	None	None
Deck	Conc, good cond.	Some spalling on east end
Drainage System	None	None
Railings	Steel-little corrosion	Steel-good
Expansion Joints	Fair	Fair
Paint	Fair	Fair
b. Abutment & Piers		
General Condition of Concrete	Good	Good-Surface laitance gone below water line
Alignment of Abutment	Good	
Approach to Bridge	Not applicable	Not applicable
Condition of Seat & Backwall	Not applicable	Not applicable

PROJECT Paper Mill Dam

DATE November 20, 1978

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Significant
Changes in Watershed Runoff Potential	None
Upstream Hazards	1 restaurant
Downstream Hazards	Monadnock Paper Mill parking lot and maintenance garage; bridge
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None posted

APPENDIX B

ENGINEERING DATA

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 23.06

Town Bennington: County Hillsboro

Stream Contoocook

Basin-Primary Merrimack River: Secondary Contoocook River

Local Name

Coordinates—Lat. 43° 00' ± 2,200: Long. 71° 55' ± 2,800

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 192 Sq. Mi.

Overall length of dam 279.3 ft.: Date of Construction 1922

Height: Stream bed to highest elev. 12.58 ft.: Max. Structure 8.08 8.03 ft.

Cost—Dam : Reservoir

DESCRIPTION O Gee Face Concrete

Waste Gates

Type

Number 1: Size 8 ft. high x 6' ft. wide

Elevation Invert 7.05: Total Area 48' sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction Concrete

Length—Total ft.: Net 141' ft.

Height of permanent section—max. 8.03 ft.: Min. ft.

Flashboards—Type Removable: Height 2.0 ft.

Elevation—Permanent Crest : Top of Flashboard

Flood Capacity 5250 cfs.: 27 cfs/sq. mi.

Abutments

Materials: Concrete

Freeboard: Max. 4.5 ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Monadnock Paper Mills—~~Sawing & Pulp~~ Bennington, N.H.

REMARKS

Canal 500' to Mill

Tabulation By N & R L T Date October 18, 1938 2/23/42

1

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 22.06

Town Bennington : County Hillsboro

Stream Contoocook

Basin-Primary Merrimack River : Secondary Contoocook River

Local Name

GENERAL DATA

Head-Max. ft.: Min. ft.: Ave. 30!

Date of Construction 1922 : Use of Power Industrial

Pondage ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar : Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number 3 : Size 8 ft. high x 6 ft. wi

Elevation of Invert 7.24 : Total Area 48! sq.

Hoist

Penstock

Number 1 45" : Material Rodney Hunt (Rope Drive)

Size : Length 800

Turbines

Number : Makers

Rating HP. per unit : Total Capacity 800 H.

Max. Dement C.F.S., per unit : Total cis.

Drive

Type

Generator

Number 1

Make General Electric D.C. 250 V.

Rating KW., per unit 200 ; Total Capacity K. W.

Exciter

Number : Make

Rating-per unit : Total Capacity K.

OUTPUT—KWHRS

19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	

OWNER Monadnock Paper Mills ~~Bennington N.H.~~ Antrim N.H.

Tabulation By A A N & R L T 4/3 Date October 19, 1938 2/23/42

Form 280

NEW HAMPSHIRE WATER RESOURCES BOARD

QUESTIONNAIRE

WATER POWERS OF NEW HAMPSHIRE

Monadnock Paper Mills
Bennington
New Hampshire

Gentlemen:

We maintain in this office a list of the water power installations in New Hampshire. In recent months we have had several inquiries concerning the water power installations in the State and have found that our information is in some cases out of date.

We are, therefore, bringing this information up to date and request your cooperation by filling in the questionnaire below with data on your development, and return it to us in the enclosed stamped envelope.

Very truly yours,

Richard S. Holmgren
Chief Engineer

RSH:GMB
Encl.

Dam No. 22.06 : Location: Contoocook River at Bennington

1. Will you please check or correct:

	Our Data	Your Corrections
Drainage Area - Sq.Mi.	192	
Head - feet	30	
Capacity (Total)	800	
Wheel - H.P.		
Generator - K.W.		

2. Is the power plant now in operation? Yes

3. If not, is the equipment in operable condition? _____

4. Is the dam in good repair? Yes

(Signed) [signature]

Date 7/23-42

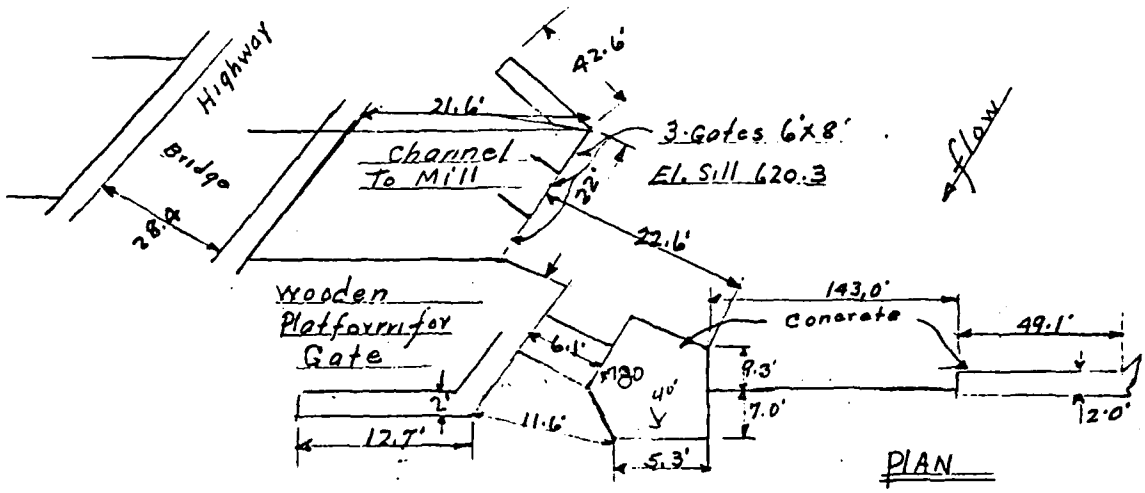
NEW HAMPSHIRE WATER RESOURCES BOARD CONCORD, N. H.

PROJECT FILE 22

SUBJECT Contoocook BENNINGTON ACC.

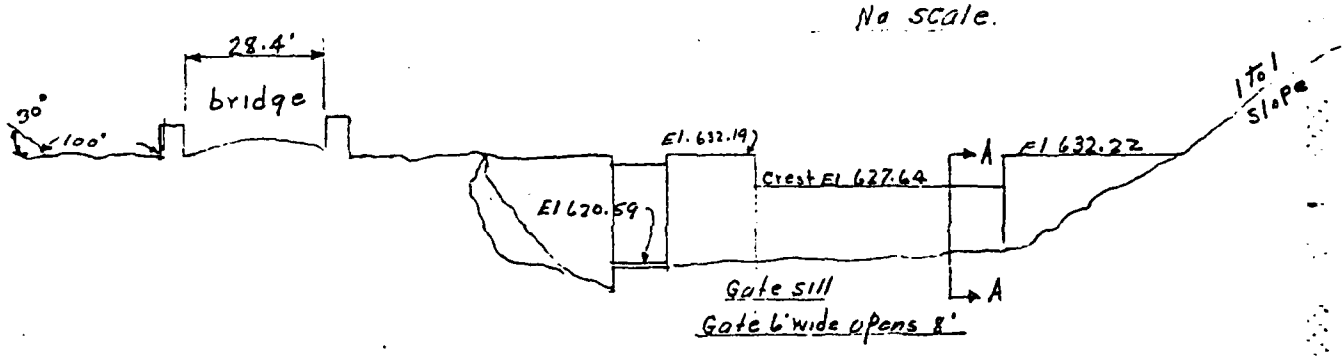
MERRIMACK Contoocook MONADNOCK PAPER MILLS

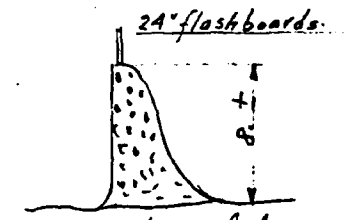
COMPUTER G.S.W. CHECKER A.R. CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC. DATE 01/



PLAN

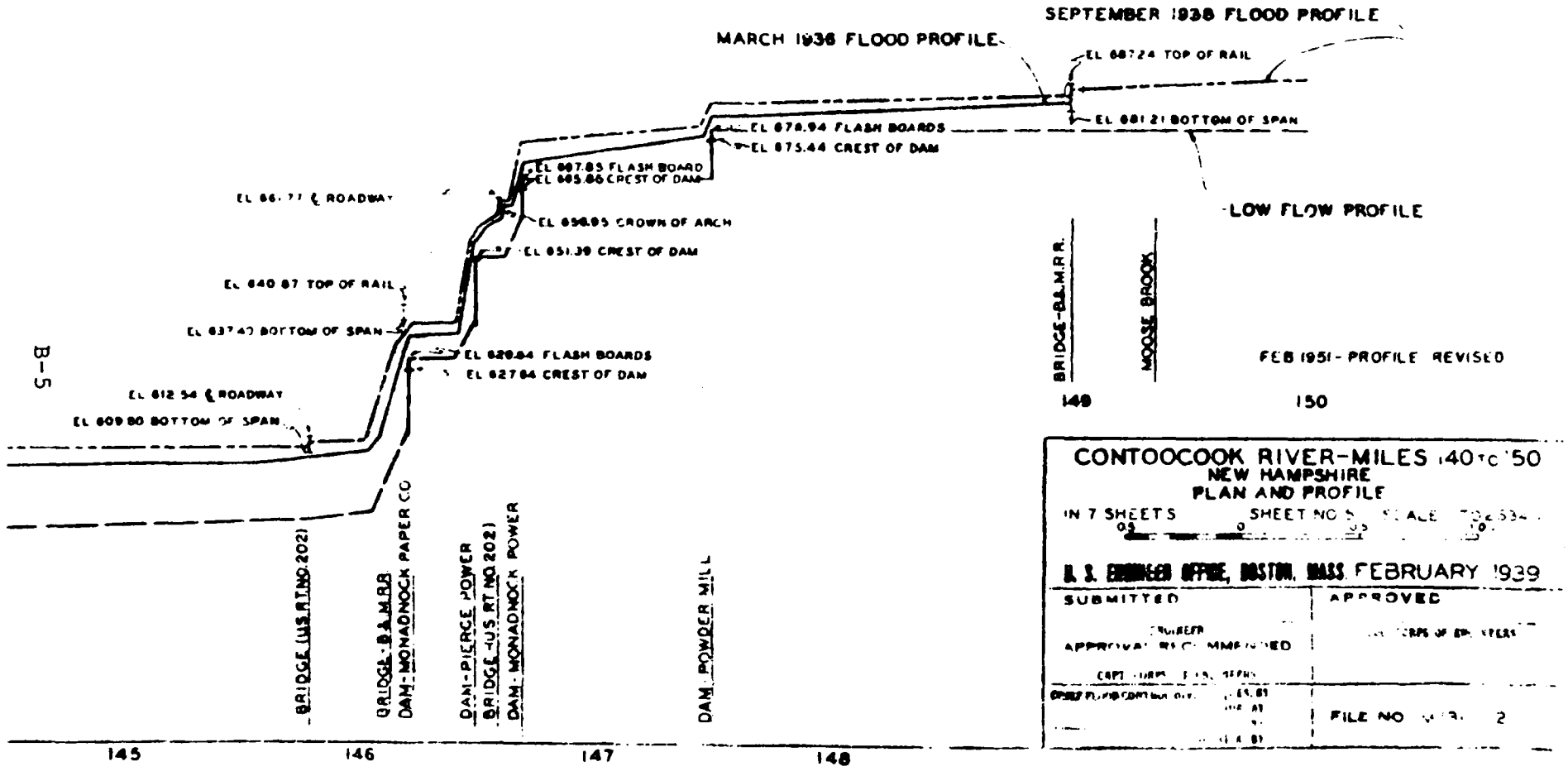
No scale.





Section A-A

Scale 1" = 1'-0"



CONTOOCOOK RIVER-MILES 140 TO 150
NEW HAMPSHIRE
PLAN AND PROFILE

IN 7 SHEETS SHEET NO 5 SCALE 1" = 5280'

U. S. ENGINEER OFFICE, BOSTON, MASS. FEBRUARY 1939

SUBMITTED	APPROVED
ENGINEER APPROVAL RECOMMENDED CHIEF, ENGINEERING DIVISION	CHIEF OF ENGINEERS
CHIEF, FLOOD CONTROL BR.	FILE NO. NED 2

Miles above Newburyport Light

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

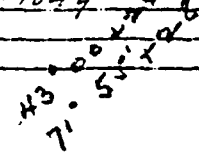
BASIN Merrimack NO. X 22.06 (190 Staff; 188 Psc
RIVER Contoocook MILES FROM MOUTH 146.3 D.A.SQ.MI. 192 ± C
TOWN Bennington OWNER Merrimack Valley Paper Mills USGS
LOCAL NAME OF DAM
BUILT 1922 DESCRIPTION Concrete Gravity

POND AREA-ACRES DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 12.5± MAX. MIN.
OVERALL LENGTH OF DAM-FT. 229.3 MAX. FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV. U.S.G.S. 627.64 LOCAL GAGE
TAILWATER ELEV. U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 141 WRB. 143 AE FREEBOARD-FT. 4.5 WRB. 4.5 AE
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 2.0 AE

WASTE GATES-NO.	WIDTH	MAX. OPENING	DEPTH SILL BELOW CREST	
1	6.0	8.0	7.05'	Waste
3	6.0	8.0	7.24'	to wheel channel

REMARKS 41 Maximum High Water 629.64
Original plans by Aberthaw Co., Boston, Mass.
PS comm. says dam 10' high 700' long, spillway 150' long
Condition good.

Assumed C = 3.9



POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
	1	800 rated	30		700 KW	45" Podney Hunt horiz tc
						GE DC 750V

USE Power for Paper Mill

REMARKS Surveyed during March 1926 Flood by W.R.B.
Maximum head 5.5 ft discharge 10,000 cfs 52 c.f.s. / sq mi
Accompanying sketch copied from Army Engineer's Field note:
Primary HP 90° of time 1857
Canal 300' long to mill Information from Mr. Braid, Chief Engr

DATE 1925 Psc.
10/4/37

DAMS AND THEIR LOCATIONS IN TOWN OF Bennington

No.	Location River, Brook, Pond or Lake		Condition Ruins or Operable	Owner	Owner's Address
1.	Powder Mill Dam	Lake	Concrete	Monadnock Paper Mills	Bennington
2.	Monadnock Power Station Dam	River	"	"	"
3.	Pierce Power Station Dam	River	"	"	"
4.	Paper Mill Dam	River	"	"	"
5. 6. 9. 10. 7.	Three Dams on two brooks Town Water works		Operable	Town of Bennington	
8.	Lake George		Non-operable	Monadnock Paper Mills	"
9.					
10.					
11.					
12.					
13.					

Arthur J. Pierce
Selectman

Town No. 4-5 Town Bennington No. 150

Data by U.S.G.S. File 1-1142

Owner Monadnock Paper Mills

River or Stream Contoocook River

Public Utility No Drainage area 192 sq. mi.

Wheel Capacity H. P. 130 { Primary H. P. 90% time } 90.4

Type of Construction Concrete

Height 14 ft. Operating Head 14 ft.

Length 272 ft. Spillway Length (No. 1) 164 ft. (No. 2) 108 ft.

Would Failure of Dam do Harm? Yes

Present Condition Fair Date 1922

1374 LWB Good 1925

PAPER MILL DAM

Town No. 6 Town Bennington No. 149

Data by L.W.B. File

Owner ~~Monadnock Paper Mills~~

River or Stream Contoocook River

Public Utility No Drainage area 184 sq. mi.

Wheel Capacity H. P. 735 { Primary H. P. 90% time } 185.7

Type of Construction Concrete

Height 10 ft. Operating Head 30 ft.

Length 200 ft. Spillway Length (No. 1) 150 ft. (No. 2) ft.

Would Failure of Dam do Harm? No

Present Condition Fair Date ~~1930~~ 1922

1374 LWB Good ~~1925~~ 1925

NEW HAMPSHIRE WATER RESOURCES BOARD
State House Annex
Concord, N. H.

December 4, 1961

Monadnock Paper Co,
Bennington, N.H.

Dear Sir:

To bring our records of hydro-electric power installations up to date, we are requesting you to furnish the following information on your generators in use at the present time:

_____ reported as 160 KW in 1951

presently using _____ KW generators.

also: 240 KW in 1951

presently using _____ KW generators.

also: 420 KW in 1951

presently using _____ KW generators

Monadnock Station 1 - 120 KVA — (22.03)
Pierce Station 1 - 220 KVA — (22.04)
1 - 500 KVA
Mill Water Wheel 1 - 750 KVA — (22.06)

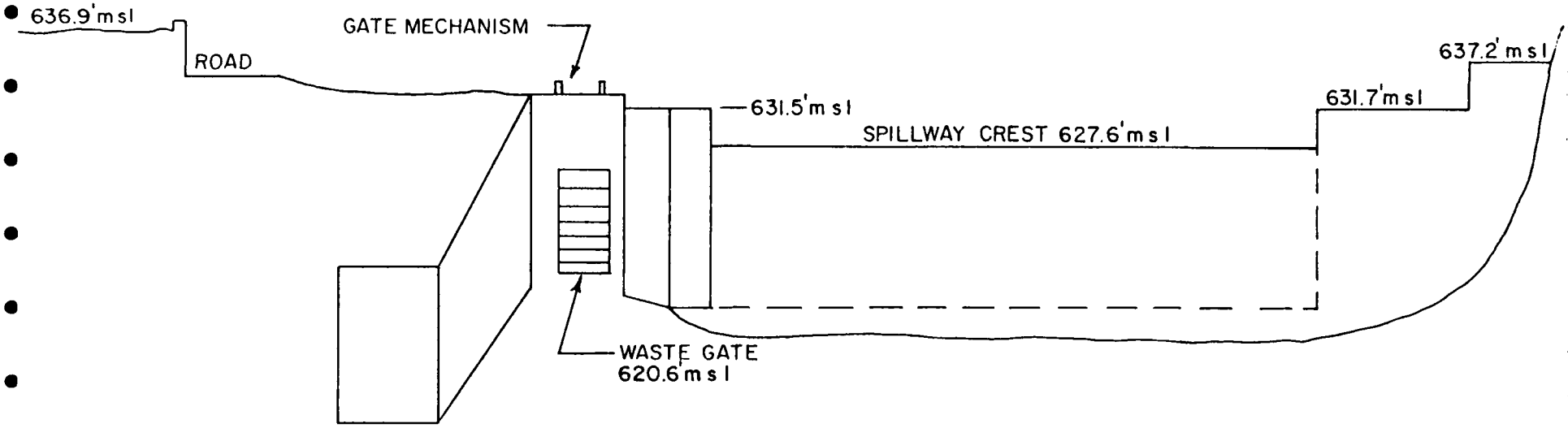
Yours very truly,

Francis C. Moore

Francis C. Moore
Civil Engineer

Above wheels & generators are in good condition and produce power when water is available.

M McBullard
Power Engineer



ELEVATION

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

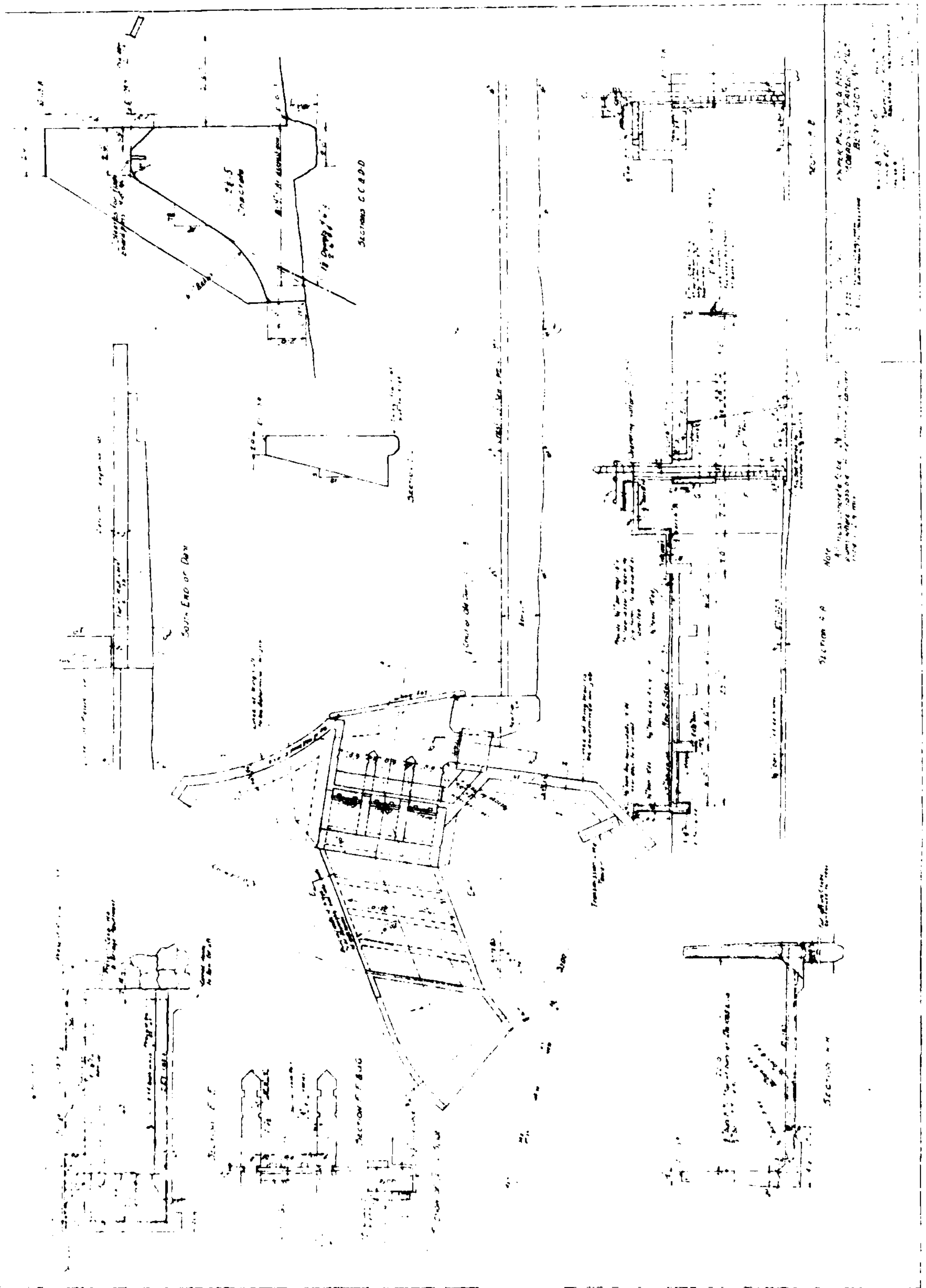
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PAPER MILL DAM

CONTOOCOOK RIVER NEW HAMPSHIRE

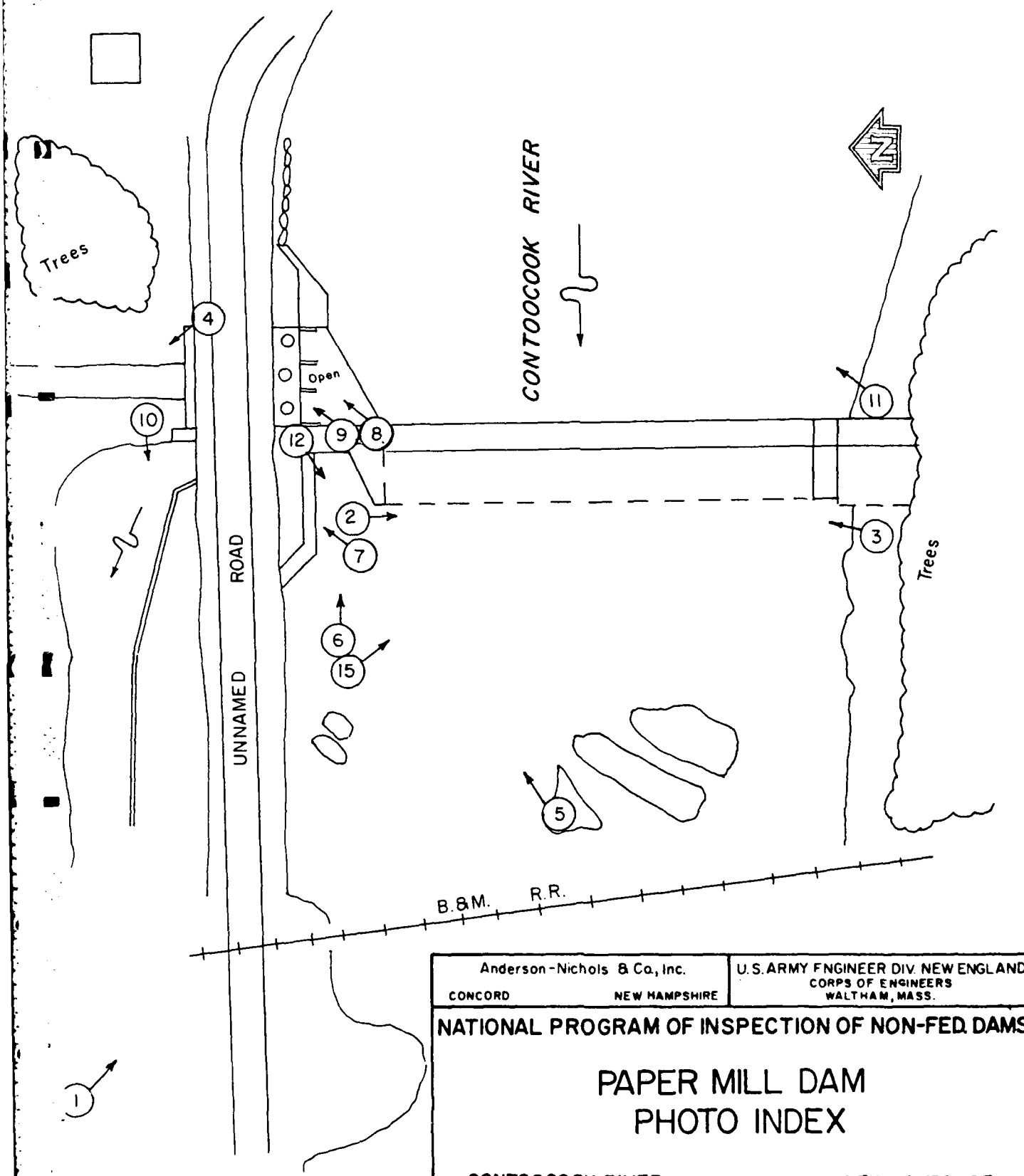
SCALE: NOT TO SCALE

DATE: FEBRUARY 1979



APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PAPER MILL DAM
PHOTO INDEX

CONTOOCOOK RIVER NEW HAMPSHIRE

SCALE: NOT TO SCALE

DATE: FEBRUARY 1979

Figure 2 - Looking south along the upstream face of the spillway. [illegible]

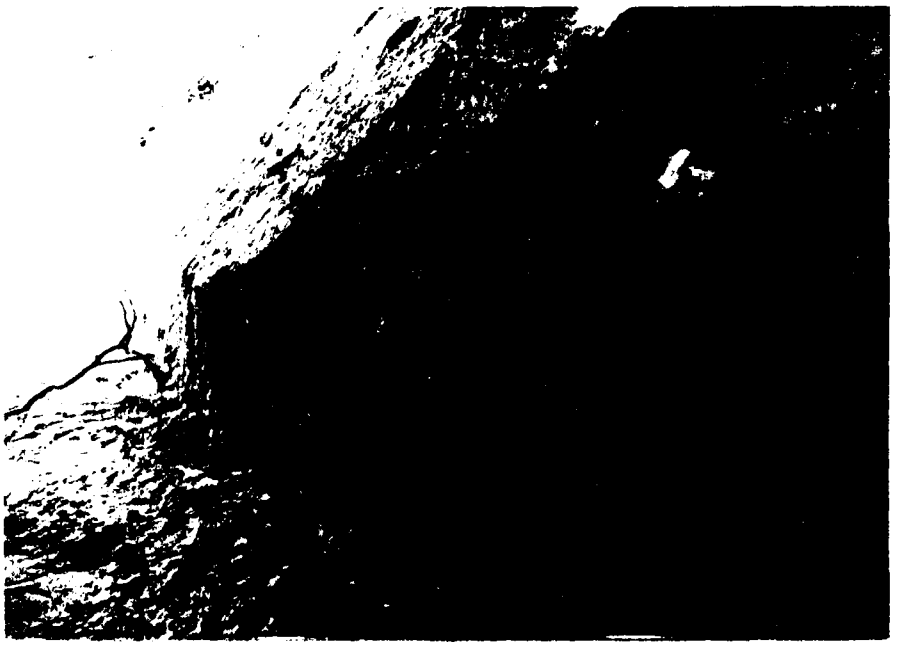


Figure 3 - Looking at the south abutment adjacent to the spillway. Note the cracking of the concrete.

Figure 4 - Looking at the upstream face of the northerly dike. Note the gravel crest.

Figure 5 - View of the [illegible] dike ... with [illegible] ...

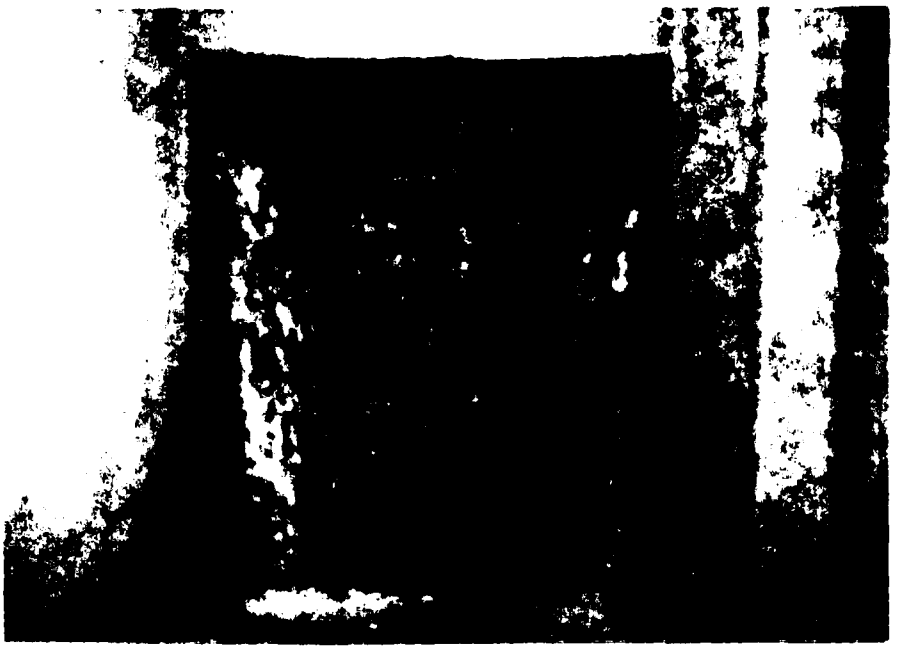


Figure 6 - View of the highway site in the waste [illegible] to the north [illegible].

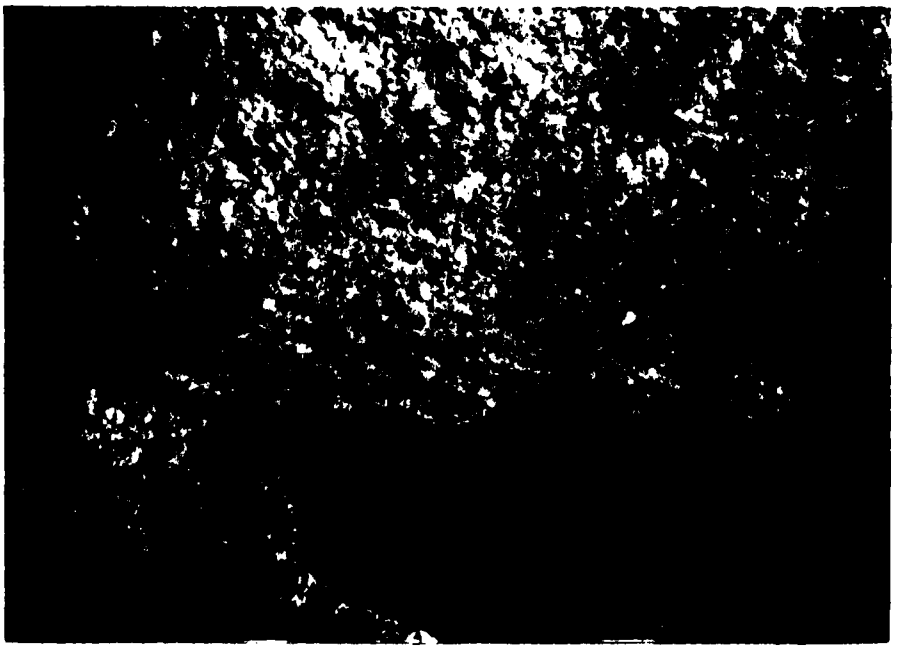


Figure 7 - View of the deteriorated and spoiled [illegible] at the base of the waste sluice.

Figure 8 - View of the trash racks and head gates. Note the spalling of the piers.

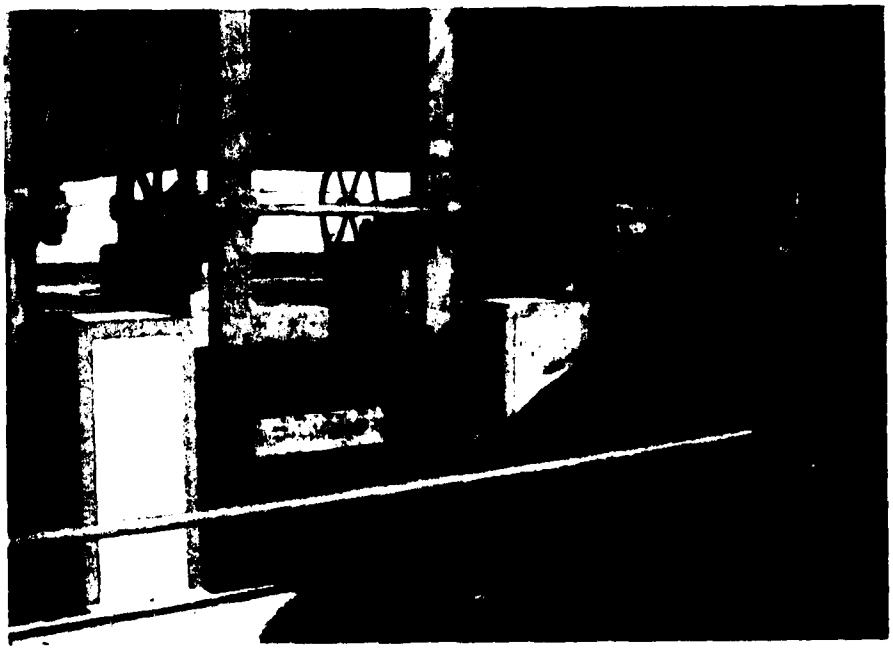


Figure 9 - Looking north at the timber head gates and the operating mechanisms.

Figure 10 - View of the canal which feeds discharge into the mill building for use in power generation and process water.

Figure 11 - Looking at the house/restaurant located on the north bank of the approach channel.

Figure 12 - Looking at the railroad bridge located about 200 feet downstream of the dam.

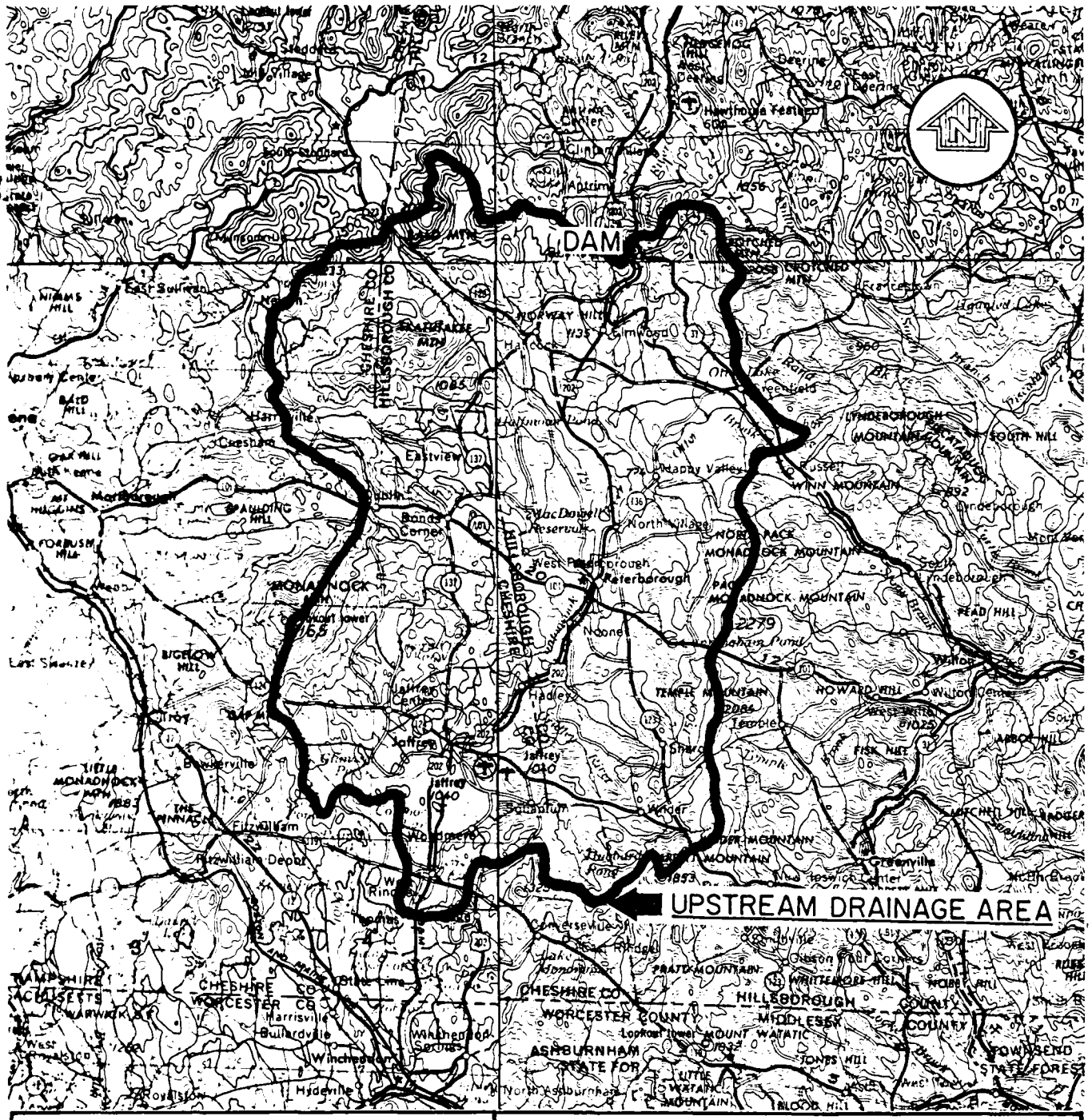
Figure 13 - View of Monadnock Paper Mills located on the east bank of the discharge channel about 1000 feet below the dam.

Figure 14 - View of the upstream face of the road crossing located approximately 2,200 feet downstream of the dam.

Figure 15 - View of the eroded section of the dam crest.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION
OF NON-FED. DAMS
PAPER MILL DAM

BENNINGTON, NEW HAMPSHIRE

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

SCALE IN MILES

0 5 10

MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING. ALBANY, NY, CT, MA, NH, VT, 1956. REV. 1974. BOSTON, MA, NH, CT, RI, ME, 1956, REV. 1970. PORTLAND, ME, NH. 1956, REV. 1972 GLENS FALLS, NY, VT, NH. 1956, REV. 1972.

Determine discharge rating curve for the dam using the weir equation $Q = CLH^{3/2}$, where the 'C' for the dam spillway crest is 3.5,* 'C' over abutments is 3.2, and 'C' over dike at right abutment 2.8. (Assuming no tailwater)

Trial #1 @ 627.60 Spillway Crest

$Q =$ 0 cfs

Trial #2 @ 628.0

$Q = 3.5(142)(0.4)^{3/2} =$ 126 cfs

Trial #3 @ 629.0

$Q = 3.5(142)(1.4)^{3/2} =$ 823 cfs

Trial #4 @ 630.0

$Q = 3.5(142)(2.4)^{3/2} =$ 1848 cfs

Trial #5 @ 631.5 maximum pool (right abut.)

$Q = 3.5(142)(3.9)^{3/2} =$ 3828 cfs

Trial #6 @ 631.7 left lower abutment

$Q = 3.5(142)(4.1)^{3/2} + 3.2(7.8)(0.2)^{3/2}$

$= 4126 + 2 =$ 4128 cfs

Trial #7 @ 633.0

$Q = 3.5(142)(5.4)^{3/2} + 3.2(7.8)(1.5)^{3/2} +$
$3.2(35)(1.3)^{3/2}$

$= 6237 + 46 + 166 =$ 6449 cfs

Trial #8 @ 635.0

$Q = 3.5(142)(7.4)^{3/2} + 3.2(7.8)(3.5)^{3/2} +$
$3.2(35)(3.3)^{3/2}$

$= 10,005 + 163 + 671 =$ 10,839 cfs

* King & Brater - Figure 5-16, Table 5-13

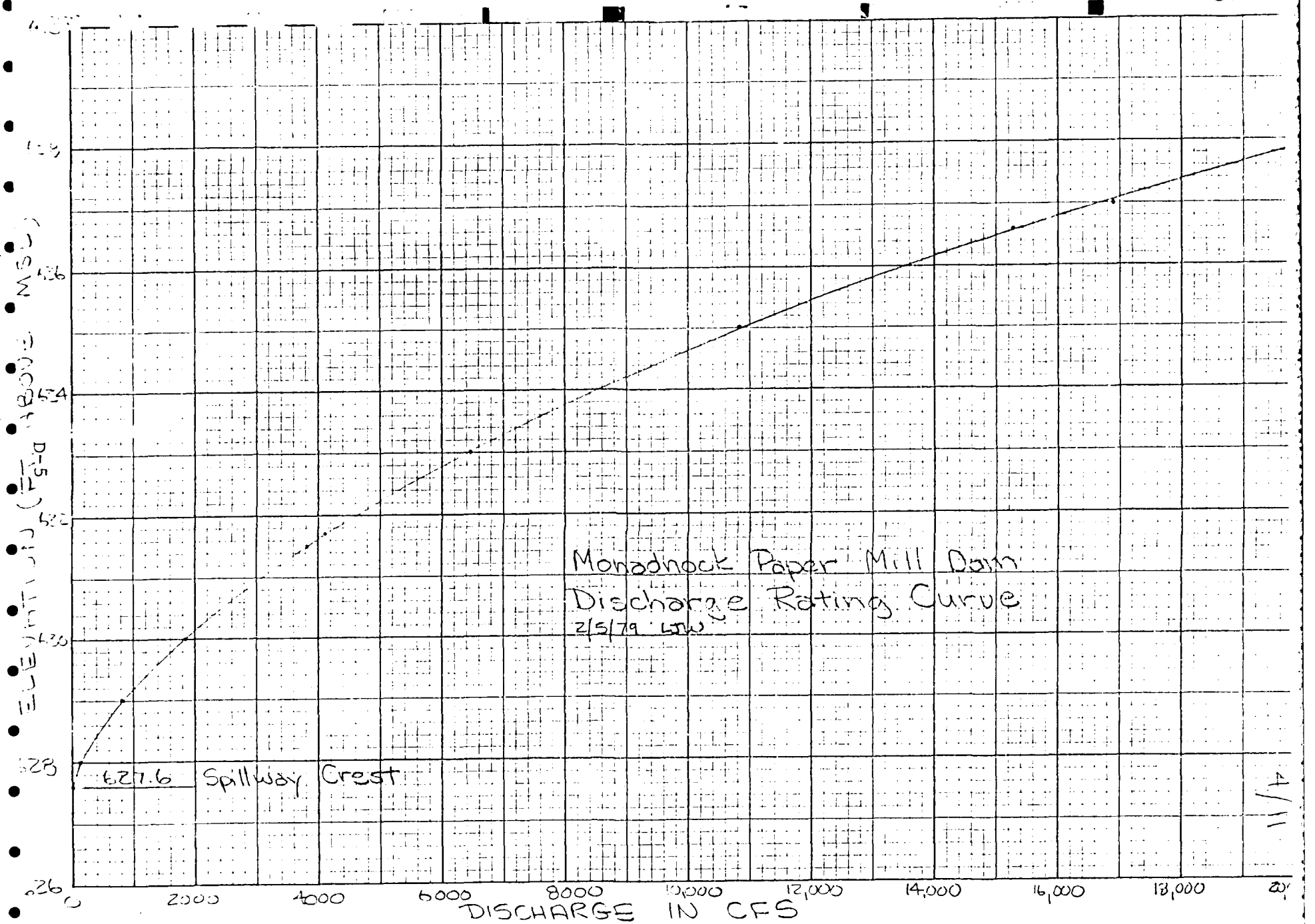
Trial #9 @ 636.6 low pt. right dike

$Q = 3.5(142)(9.0)^{3/2} + 3.2(7.8)(5.1)^{3/2} +$
$3.2(35)(4.9)^{3/2} + 3.2(4.5)(1.3)^{3/2} +$
$3.2(38)(1.4)^{3/2} + 3.2(25)(1.36)^{3/2}$
$= 13,419 + 287 + 1215 + 21 + 201 + 129$
$= \underline{15,272 \text{ cfs}}$

Trial #10 @ 637.0 Stone wall

$Q = 3.5(142)(9.4)^{3/2} + 3.2(7.8)(5.5)^{3/2} +$
$3.2(35)(5.3)^{3/2} + 3.2(3.0)(0.74)^{3/2} +$
$3.2(7.8)(5.5)^{3/2} + 3.2(38)(1.8)^{3/2} +$
$3.2(25)(1.76)^{3/2} + 2.8(170)(0.3)^{3/2}$
$= 14,323 + 322 + 1367 + 6 + 322 +$
$294 + 187 + 78$
$= \underline{16,900 \text{ cfs}}$

Use the above trials to develop a discharge rating curve for Paper Mill Dam.


Monadnock Paper Mill Dam
Discharge Rating Curve
2/5/79 LDW
627.6 Spillway Crest
ELEVATION (FT MSL)
DISCHARGE IN CFS
0
2000
4000
6000
8000
10,000
12,000
14,000
16,000
18,000
526
528
530
532
534
536

D-5

11/4

Paper Mill Dam

BREACH ANALYSIS - to determine downstream hazard classification. Do breach first at normal flow conditions using Mean Annual Flow. Using Water Resources Data for New Hampshire and Vermont, Water Year 1976, U.S. Geological Survey Water-Data Report NH-VT-76-1 August 1977:

At gage stations on Contoocook River

DA @ 68.1 mi^2 - MAF = 144 cfs or 2.11 CSM

DA @ 358 mi^2 - MAF = 858 cfs or 2.33 CSM

Due to upstream storage of Powder Mill Pond, a 2.33 CSM value is applied to the DA @ Paper Mill Dam (DA ≈ 191 mi^2)

∴ Normal Flow Conditions (MAF) = 191 × 2.33 = 445 cfs

this corresponds to 0.9' depth over spillway.

$Q_{p1} = 8/27\ W_b \sqrt{g}\ y_o^{3/2}$

W_b = breach width

$g = 32.2\ ft/sec^2$

y_o = Pool elev. - u/s river bed

628.5 or 0.9' over spillway crest. Upstream river bed shown on plans ≈ 619.

@ Paper Mill Dam

$W_b = 142 \times 0.4 = 56.8' \approx 57'$

$y_o = 628.5 - 619 = 9.5$

BREACH @ NORMAL FLOW

From above equation: Q = 2806 cfs

Q over dam other than breached area:

$Q = 3.5 \times 85 \times 0.9^{3/2} = 254$ cfs

Total Breach Q (NORMAL) = 2806 + 254 =

3060 cfs

Use a typical cross section along the downstream reach from the dam to the road crossing at Monadnock Mills and establish a rating curve using the following Mannings Equation:

$$Q = \frac{1.49}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

n = composite 'n' value
A = area of section (ft^2)
R = A/WP (wetted perimeter)
S = slope of reach

Length of reach = 2400'
Elev. @ d/s toe = 617
Elev. @ end reach = 600
Slope = 0.007
Composite 'n' = 0.09

Trial #1 Assume stage of 5'

Area $_{\text{TRAPEZOID}}$ = ½ height (base$_1$ + base$_2$)
Area = ½ · 5 (100 + 175)
= 688 ft^2

WP = 100 + 25 + 50 = 175
$R = \frac{688}{175} = 3.93$

$$Q = \frac{1.49}{.09} \cdot 688 \cdot 3.93^{2/3} \cdot .007^{1/2}$$

$Q = \underline{2384 \text{ cfs}}$

Trial #2 Assume stage of 10'

Area = $\frac{1}{2}$ 10 (100 + 250)
= 1750 ft^2
WP = 100 + 51 + 100 = 251
R = $\frac{1750}{251}$ = 6.972

$Q = \frac{1.49}{.09} \cdot 1750 \cdot 6.972^{2/3} \cdot .007^{1/2}$
$Q = \underline{8903 \text{ cfs}}$

Trial #3 Assume stage of 3'
Area = $\frac{1}{2}$ 3 (100 + 145)
= 367.5
WP = 100 + 15 + 30 = 145
R = $\frac{367.5}{145}$ = 2.5345

$Q = \frac{1.49}{.09} \cdot 367.5 \cdot 2.5345^{2/3} \cdot .007^{1/2}$
$Q = \underline{949 \text{ cfs}}$

Trial #4 Assume stage of 7'
Area = $\frac{1}{2}$ 7 (100 + 205)
= 1067.5 ft^2
WP = 100 + 36 + 70 = 206
R = $\frac{1067.5}{206}$ = 5.182

$Q = \frac{1.49}{.09} \cdot 1067.5 \cdot 5.182^{2/3} \cdot .007^{1/2}$
= $\underline{4452 \text{ cfs}}$

Use the above trials to establish a downstream x-section rating curve.

Total Breach Q = 3060 cfs
Stage = 5.7 feet

Antecedent discharge =
$3.5 \cdot 142 \cdot 0.9^{3/2} = 424$ cfs
Stage = 1.7 feet

∴ Increase in stage caused by breach @ normal flow would be ≤ 4 feet.

Breach @ top of dam - 631.5' MSL

$Q_{p1} = \frac{8}{27} W_b \sqrt{g}\, y_o^{3/2}$
$= \frac{8}{27} \times 57 \times \sqrt{32.2} \times 12.5^{3/2}$
$= 4236$ cfs

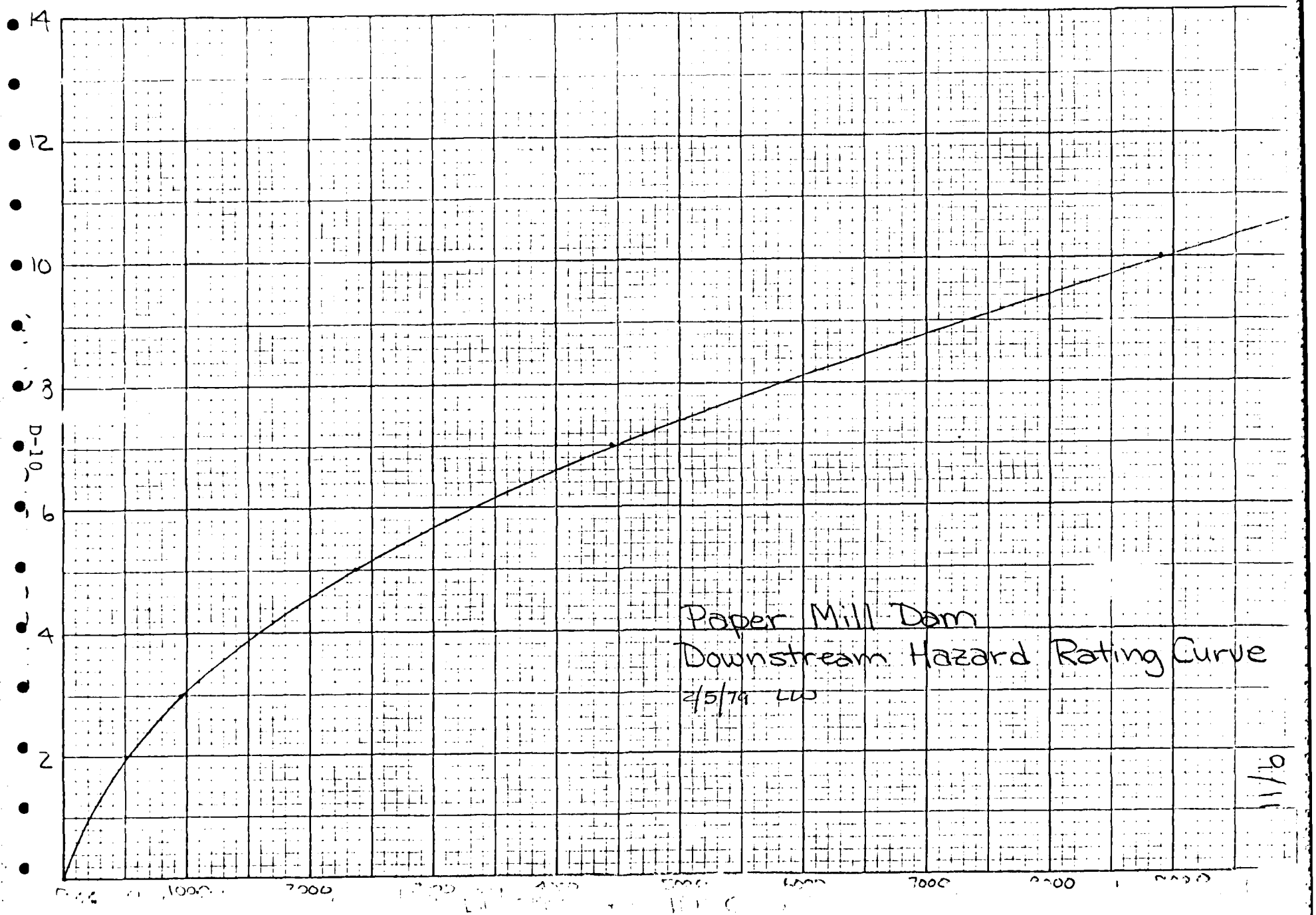
Q over dam other than breached area:
$Q = CLH^{3/2}$
$= 3.5 \cdot 85 \cdot 3.9^{3/2}$
$= 2291$ cfs

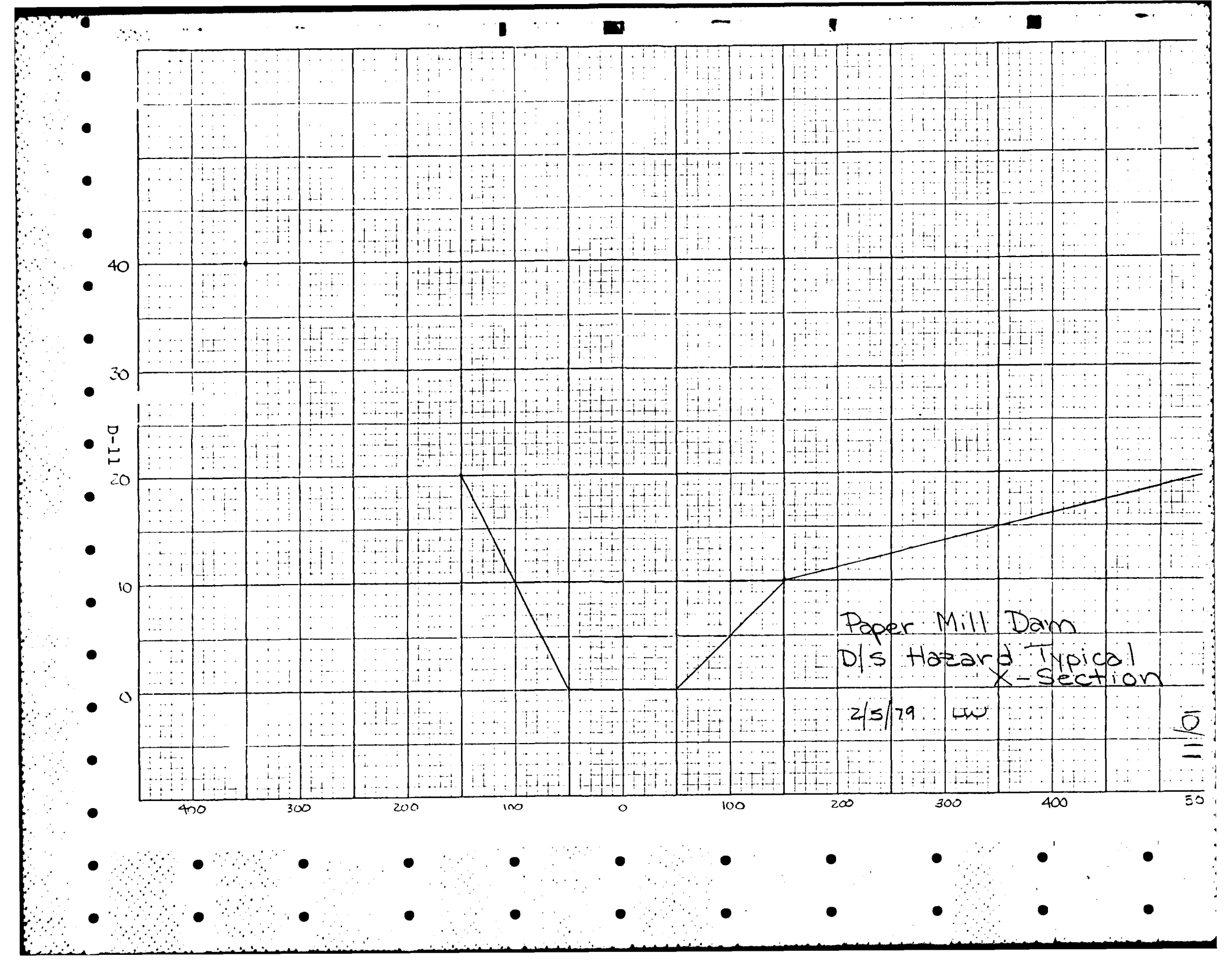
Total breach Q = 6527 cfs

Stage @ 6527 = 8.5 feet

Antecedent discharge = 3828 cfs = Stage 6.2 feet
∴ Increase in stage caused by breach @ top of dam would be 2.3 feet.

CONCLUSIONS: Breach at top of dam would produce the worst downstream damage. The breach at normal flow conditions would stay in bank. Because of the already high tailwater conditions at flow at top of dam and then the increase in stage at breach, this would produce the greater downst. Loss of life would be few, if any. Appreciable property damage would occur to the maintenance garage and parking lot just downstream.


14
12
10
8
6
4
2
D-10
1000
7000
Paper Mill Dam
Downstream Hazard Rating Curve
2/5/79 LLD


40
30
20
10
0
400
300
200
100
0
100
200
300
400
500
Paper Mill Dam
D/S Hazard Typical
X-Section
2/5/79 LW
11/01

11/11

GATE CAPACITIES

Determine approximate gate capacities at top of dam - 631.5' MSL

Waste Gate

6'W x 8' H
Invert - 620.6' MSL
Centerline - 624.6' MSL

$Q = CA\sqrt{2gh}$ ORIFICE EQUATION

$Q = (0.7)(48)(\sqrt{64.4 \cdot 6.9})$
$Q = 708 \approx$ 710 cfs

Head Gates

The capacity of the head gates is controlled by the turbine capacity in the plant which is unknown.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY	MO	YR
	251			11	02				PAPER MILL DAM	4300.0	7155.0			1579

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	CONTOOCOOK RIVER

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	05	CONTOOCOOK	HENNIKER	0	659

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE FT.)	(27) NORMAL (ACRE FT.)	(28) DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
CTPG	1922	HS	19	13	50	25	FED	N	N	N	N	21FEB79

(29) REMARKS
NID ID#220N 20=1979 21=CONCRETE DAM OF RIVER 22=REPAIRS IN 1939

(30) D/S HAS	(31) SPILLWAY CONC (FT.)	(32) TYPE	(33) WIDTH (FT.)	(34) MAXIMUM DISCHARGE (FT.)	(35) VOLUME OF DAM (CY.)	(36) POWER CAPACITY INSTALLED (MW)	(37) PROPOSED (MW)	(38) NAVIGATION LOCKS NO	(39) LENGTH (FT.)	(40) WIDTH (FT.)	(41) LENGTH (FT.)	(42) WIDTH (FT.)	(43) LENGTH (FT.)	(44) WIDTH (FT.)	(45) LENGTH (FT.)	(46) WIDTH (FT.)
	22			5820												

(47) OWNER	(48) ENGINEERING BY	(49) CONSTRUCTION BY
PUBLIC PAPER MILLS		AMERICAN CONSTRUCTION

(50) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
FEDERAL POWER COMMISSION	STATE	STATE	STATE

(52) INSPECTION BY	(53) INSPECTION DATE DAY	MO	YR	(54) AUTHORITY FOR INSPECTION
WILLIAM F. CLEPPER COMPANY INC	20	NOV	78	PL 92-367

(55) REMARKS

END

FILMED

8-85

DTIC